

General Purpose of the Environmental Water Account

The EWA is a water management technique that is designed to provide both improved fish protection and increased water supply reliability using the existing Delta facilities during CALFED Stage 1. The water supply target of 5 to 6 MAF requires that the Delta export pumping plants be operated for the majority of the time. However, efforts to further reduce fish entrainment effects would restrict the number of days with high export pumping.

Entrainment losses occur when a vulnerable life stage of a fish species of interest is directly entrained at the pumping facilities or indirectly drawn towards the vicinity of the pumping facilities. The daily entrainment loss is assumed proportional to the density of fish in the south Delta water and the volume of water diverted. The density of fish in the south Delta is governed by natural spawning and migration events, but may also be influenced by the hydrodynamic transport and mixing conditions that are controlled by the Delta inflow and south Delta pumping patterns. Changes in Delta inflow or south Delta pumping patterns may change the distribution of vulnerable fish within the Delta channels. Many of the existing Delta objectives govern basic Delta hydrodynamic conditions that are thought to influence entrainment losses. In addition to operating the existing fish salvage facilities and complying with current Delta flow and salinity objectives, the entrainment of fish in the Delta may be reduced with the following basic EWA entrainment management "actions":

- Sacramento River inflow can be increased to control conditions along the migratory pathway for fish entering the Delta from the Sacramento River corridor, and to regulate Delta outflow and other hydrodynamic conditions.
- The Delta Cross Channel (DCC) gates can be closed to reduce the diversion of fish into the central Delta, but closure of the DCC gates will also influence hydrodynamic conditions in the central Delta (i.e. QWEST).
- San Joaquin River inflow can be increased to control conditions along the migratory pathway for fish entering the Delta from the San Joaquin River corridor, and to regulate central Delta hydrodynamic conditions.
- The Head of Old River (HOR) barrier can be closed to reduce the diversion of fish into the south Delta channels, but closure of the HOR barrier will also influence hydrodynamic conditions in the south Delta (i.e. reverse net flow from the central Delta).
- Delta export pumping can be reduced to protect vulnerable life stages of fish species of interest during periods when high densities of these fish are observed in the south Delta or in central Delta habitat.

The basic challenge during CALFED Stage 1 is to adaptively manage the south Delta pumping to provide the greatest possible pumping in periods with low risk of entrainment and reduce

pumping only when entrainment risk is higher. The DNCT team has evaluated several different approaches for accomplishing this task. One necessary component will be fish distribution monitoring (i.e. real-time monitoring) that will alert the operators to the presence of high fish densities. The second component is an Environmental Water Account (EWA) that is proposed to provide an environmental water supply and allow direct control over the timing of pumping restrictions to reduce entrainment.

Environmental Water Account

The EWA would be a combination of real water, storage and conveyance capacity, and necessary funding and agreements to allow increased pumping during periods of low fish entrainment risk and reduced pumping during periods of high fish entrainment risk. The EWA is assumed to be a method for providing additional fish protection by allowing exports to be shifted to periods that have lower environmental effects, without reducing net water supply exports. The EWA might be used to actually increase water supply slightly, if some of the relatively fixed Delta export restrictions were found to be overly protective and could be relaxed during some periods.

The EWA would provide an accounting method to allow the shifting of exports from one period to another, without causing any net reduction in water supply. The EWA would put definitive boundaries on the amount of water that can be used for entrainment reduction, and would provide assurances for the payback of any shortages that these reductions may cause. The EWA has the following advantages compared with the no action alternative (i.e. no further entrainment reduction measures) or compared with the likely alternative of imposing additional export restrictions using prescriptive (i.e. fixed) standards:

- EWA will provide the flexibility to increase and decrease exports consistent with fish protection goals and real-time monitoring results.
- The EWA will allow more efficient use of water because only the water necessary for protection will be used, and the EWA manager will look for periods of increased exports to replenish the EWA.
- The EWA includes a balanced accounting of water supply benefits achieved by relaxing existing fixed standards and the water supply impacts caused by increased reservoir releases or reduced exports for fisheries protection.

Perhaps the most important remaining task for creating and operating a successful EWA will be development of the biological decision-making framework for EWA actions and performance measures for evaluating EWA fish protection actions.

Modeling Appendix for EWA Paper

Daily EWA Simulation Model Features and Results

A combination of DWRSIM monthly planning model results and a daily simulation model of the Delta flows and exports was used for the EWA gaming simulations. The DWRSIM results were used to approximate the baseline conditions that might include different future facilities or operating constraints. The daily model was then used to show the daily patterns of Delta inflows and the effects of various Delta objectives on required Delta outflow and allowable export pumping. The south-of-Delta delivery patterns and San Luis Reservoir storage conditions were included in the daily modeling. The daily model included the historic CVP and SWP salvage density data, which were used to guide the EWA export and inflow adjustments in a month-by-month gaming exercise. The major features of the daily simulation model are briefly described below.

The daily model simulations use the historical daily Delta inflows (i.e., DAYFLOW records) for any selected recent year of record (i.e. 1981-1995). The daily historical data can be adjusted to match the monthly average DWRSIM results by adding the difference between the DWRSIM monthly value and the historical average monthly value. The daily model allows the user to specify a wide range of monthly Delta objectives, such as those included in the 1995 WQCP. For example, the allowable export pumping capacity can be changed to represent increased Banks pumping capacity. Monthly minimum Rio Vista and QWEST flow requirements can be imposed, and DCC gates or the HOR barrier can be closed during a month by simply changing a model parameter.

Daily Delta Calculations

The allowable Delta exports that would satisfy each of the specified Delta objectives are calculated for each day so that the effects of changing individual Delta objectives can be easily investigated. The model calculates daily X2 requirements and export/inflow ratio limits, for example, and determines adjustments in export that would be required to satisfy these specified objectives, assuming historical (or adjusted) inflows. The daily water supply deliveries can be historical or a future assumed demand (i.e., 6 MAF) pattern can be specified. San Luis reservoir storage is tracked because San Luis storage may limit exports during some periods.

The daily model simulates fish protection trigger(s) that can be specified as monthly density value for each of five fish species. Full allowable pumping is used if the historical salvage density is less than the minimum specified value. Allowable pumping is reduced to a specified percentage of otherwise allowable pumping if the density is greater than the specified value.

The daily model allows the export limits to be specified and the E/I ratio to be relaxed on a weekly basis. The daily model tracks the EWA adjustments to the baseline conditions. Periods

of relaxation in the E/I ratio or increased export limits will produce an EWA credit, with increased San Luis storage. Periods of fish triggers or lowered export limits will reduce the EWA account and may create an EWA debt (i.e., reduced San Luis storage).

Daily Reservoir Calculations

The five upstream reservoirs that control Sacramento River inflow (i.e., Folsom, New Bullards Bar, Oroville, Shasta, and Clair Engle) were included in the EWA daily modeling. Daily historical reservoir operations data are used as the basis for making adjustments in required minimum releases (i.e., AFRP flow targets) and specified water supply diversions. The daily simulation of upstream reservoirs allows potential EWA changes in Delta exports to be coordinated with upstream actions to reduce reservoir releases to minimum required flows and hold EWA water in upstream storage, unless the reservoir storage is already at flood control levels. These upstream reservoir management opportunities have not been fully explored in the EWA gaming simulations, and more efforts at coordination between Delta actions and upstream actions should be included in future gaming exercises.

Calculation of EWA Fish benefits

Measurements of fish distribution and abundance (i.e. density) are the fundamental biological data that must be evaluated to estimate the potential benefits of EWA changes in flows and export pumping patterns. The timing of a species within the Delta (i.e., migration or spawning) is important because this controls the fraction of the population that is exposed to Delta conditions. The location of the population within the Delta is important because this controls the fraction of the population that is exposed to direct and indirect effects caused by changes in a particular flow or export pumping. Because the available biological data is generally incomplete compared with the daily hydrologic and water quality conditions, it is necessary to make broad assumptions about the relationships between hydrologic and water quality conditions and the resulting fish distribution and abundance patterns in the Delta. Some of the available biological information and assumptions are described in the following sections.

Historical CVP and SWP Salvage Data

The EWA gaming simulations have used the historical salvage density (fish/TAF) from the CVP and SWP pumping plants to estimate the baseline and EWA-modified entrainment that would occur with EWA-modified export pumping patterns. Converting the historical salvage records to density provides a standardized measure of relative fish abundance near the pumps that is assumed to be independent of the pumping rate. However, this assumes that changes in future allowable pumping would not change the basic fish occurrence (i.e., timing) and abundance patterns. Under this assumption, the calculated entrainment will vary directly with the pumping rate. The greatest number of fish can be protected by reducing the exports during periods with the greatest historical salvage density.

The pumping pattern may have a secondary effect on salvage density, if the fish population is not uniform throughout the Delta, and increased pumping could draw more water with high fish density from the central Delta into the south Delta. This might occur, for example, if the majority of the chinook originate from the San Joaquin River because higher pumping may draw a greater fraction of the SJR chinook towards the pumps. This might also occur for delta smelt that have spawned in the central or north Delta and are drifting passively in the water column. Greater than historical pumping could increase the smelt density, and less pumping may delay and reduce the smelt density in the vicinity of the pumps. These possible changes in historical fish density have not been fully incorporated into the EWA gaming calculations. Historical smelt density has been reduced with an assumed relationship between smelt density and X2 location. Each kilometer movement downstream is assumed to reduce the historical smelt density by 10%.

Similar adjustments in historic salvage density of specific fish species caused by changes in other Delta flows could be included in the calculations. For example, changes in historic chinook salvage density and historic splittail salvage density should probably be adjusted if the Head of Old River barrier is simulated to be closed, because a majority of these fish are likely to enter the Delta by migrating down the San Joaquin River. However, assumptions about how to adjust historical salvage density for various changes in Delta inflows and channel flows have not yet been specified by the DNCT team, and are not included in the daily model calculations.

The gaming simulations of the EWA have simulated the general effects of flexible pumping on daily allowable exports for a series of study years (i.e. 1991-1995). The goal of the EWA gaming simulations is to combine the most accurate representation of reservoir storage, river flows and Delta water management constraints with the best available biological data about fish abundance and distribution, so that EWA adjustments will provide the greatest possible benefits to important fish populations. The major uncertainty in these gaming exercises is in the expected response of the historical fish density to changes in exports, flows, salinity, and other habitat conditions. More historical fish density data as well as improved calculations of the likely effects of flows and exports on the historical fish density patterns are both needed for future EWA gaming simulations.